TRENDS RESEARCH & ADVISORY
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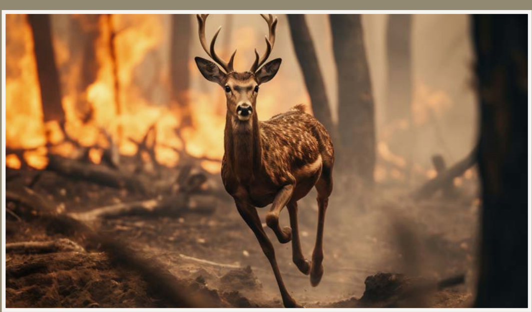
FUTURE TRENDS

Report



CANADA VIRTUAL OFFICE

Issue no. 25 - August 2026

FUTURE TRENDS

Report

Future Trends Report, published in English and Arabic by TRENDS Virtual Office in Montreal, stands out as a distinctive publication dedicated to highlighting:

1. the most important forward-looking studies that aim to identify future trends, analyze various variables that may influence these trends, and determine the best future scenarios.
2. the most important applied studies that explore the application of knowledge, scientific theories, and information to solve current problems and overcome future challenges.
3. the most important illustrative and graphic forms that visually summarize significant studies, helping readers understand the trends and challenges of the future world.

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1 Prospective research

Britain's Biodiversity at a Crossroads: Predicting Nature's Future Before It Is Too Late

Cooke, R., Burton, V. J., Brown, C., Harrower, C. A., White, S. M., Huntingford, C., et al. (2026). Future scenarios for British biodiversity under climate and land-use change. Nature Communications, 17, Article 2704.

Cooke et al. (2026) investigate how climate change and land-use change could reshape biodiversity across Great Britain by the end of the century. Rather than examining individual species in isolation, the authors model changes in entire ecological communities, arguing that understanding community reorganization provides a more realistic picture of future ecosystems.

As they state, "actions taken during the next 20 years are crucial to mitigate the worst effects of climate and land-use change for biodiversity in Britain" (Cooke et al., 2026).
Using Generalised Dissimilarity Models (GDMs), the researchers project biodiversity changes under multiple climate pathways (Representative Concentration Pathways, RCPs) and socioeconomic scenarios (Shared Socioeconomic Pathways, SSPs) extending to 2080. This modeling framework allows the authors to evaluate changes in species composition, the disappearance of existing ecological communities, the emergence of novel communities, and the number of species likely to face extinction.
Figure 1 effectively summarizes the modeling workflow, illustrating how biological observations are integrated with climate and land-use projections to generate future biodiversity scenarios (Cooke et al., 2026, Figure 1). The figure highlights the study's strength in linking ecological data with policy-relevant future scenarios rather than relying solely on historical trends. Figure 2 presents one of the most significant findings: under the high-emissions scenario (RCP 8.5), plant communities could experience approximately 48% compositional turnover by 2070, while birds and butterflies also undergo substantial ecological restructuring (Cooke et al., 2026, Figure 2). These results suggest that even where species persist, ecosystems may function very differently because community composition will have fundamentally changed.
Across all scenarios, biodiversity is projected to experience extensive reorganization, with current bioclimates disappearing and new ecological assemblages emerging. The most damaging outcomes occur under scenarios combining severe climate change with intensive agricultural expansion and urbanization. The authors estimate that optimistic pathways could decrease the number of species heading toward extinction by 32% for plants, 20% for birds, and 14% for butterflies compared with pessimistic scenarios. Nevertheless, even the most favorable futures still involve considerable ecological change.
The study concludes that conservation efforts must anticipate future environmental conditions rather than attempting to preserve historical ecosystems. Cooke et al. recommend improving biodiversity forecasting through more detailed species interactions, dispersal dynamics, and adaptive management strategies, emphasizing that ecological forecasting should become a central component of conservation planning in a rapidly changing climate.

Optimistic pathways could reduce extinction risks by 32% for plants, 20% for birds, and 14% for butterflies compared to pessimistic scenarios.

Conservation efforts should anticipate future environmental conditions instead of trying to preserve historical ecosystems.

Prospective research

When Climate Redraws the Ecological Map: Forecasting Europe's Future Bioclimates

Ferreiro-Lera, G.-B., Penas, Á., & del Río, S. (2026). Projected reorganization of Euro-Mediterranean bioclimates under climate change: Evidence from CMIP6 multi-model ensemble. Earth Systems and Environment.

Ferreiro-Lera, Penas, and del Río (2026) examine how climate change is expected to transform the distribution of bioclimatic zones across Europe and the Mediterranean Basin during the twenty-first century.

Rather than focusing on individual species, the authors investigate the environmental conditions that support entire ecosystems, arguing that shifts in climate will inevitably redefine ecological boundaries. Their prospective study seeks to anticipate these changes before they occur, providing information that can guide biodiversity conservation, forest management, and environmental policy. The authors emphasize that future ecosystem planning must account for accelerating climatic change rather than relying on historical climatic patterns.

To achieve this objective, the researchers employ projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6), using an ensemble of global climate models under multiple greenhouse gas emission scenarios. They compare present-day climatic conditions with projected climates throughout the century to determine how European bioclimates are likely to reorganize. By combining climatic variables such as temperature and precipitation with established bioclimatic classifications, the study produces detailed spatial forecasts of future ecological conditions across the continent.

The most compelling visualization appears in figures 4 and 5 of the paper, which compare present and projected bioclimatic distributions under different emission scenarios. These maps illustrate a pronounced northward and upward expansion of warmer and drier Mediterranean climates, accompanied by a contraction of colder temperate and mountain bioclimates.

The modeling results indicate that Mediterranean conditions could expand substantially into central Europe by the end of the century under high-emission scenarios. Such changes have significant ecological implications because many plant and animal species are closely adapted to particular bioclimatic conditions. The authors acknowledge that uncertainties remain regarding regional climate projections and species' adaptive capacities, yet they argue that ensemble modeling provides a more robust basis for ecological forecasting than relying on individual climate models. They recommend integrating future land-use change, species dispersal, and ecological interactions into subsequent research to improve predictive accuracy. Overall, the study demonstrates that Europe's future ecosystems will likely be defined less by current political boundaries than by rapidly shifting climatic conditions, reinforcing the importance of proactive conservation strategies designed for the landscapes of tomorrow rather than those of today.

Ecosystem planning must account for accelerating climatic change rather than relying on historical climatic patterns.

Climate change is expected to reorganize Europe's environmental structure on a continental scale.

Prospective research

A Future of Compounding Extremes: How Climate Change Could Reshape Wildlife Survival

Heinicke, S., Zantout, K., Kühl, H. S., Reyer, C. P. O., Zimmermann, S., Billing, M., et al. (2026). Land vertebrates increasingly exposed to multiple extreme events by 2085. Nature Ecology & Evolution.

Heinicke et al. (2026) explore one of the most pressing questions in contemporary ecology: how will terrestrial vertebrates cope with the increasing overlap of climate-related extreme events? Rather than assessing individual hazards in isolation, the authors investigate the cumulative exposure of mammals, birds, reptiles, and amphibians to multiple climatic extremes projected throughout the twenty-first century.

Their prospective approach recognizes that future biodiversity will be shaped not only by gradual climate warming but also by the interaction of heatwaves, droughts, floods, wildfires, and tropical cyclones. As the authors observe, "multiple climate extremes are becoming the new normal," emphasizing that ecological risk is increasingly driven by the coincidence of several environmental disturbances rather than a single event.

The study integrates species distribution data for more than 30,000 terrestrial vertebrate species with climate projections derived from the latest global climate models. Future exposure is estimated under several Shared Socioeconomic Pathways (SSPs), extending to 2085, allowing the researchers to compare biodiversity outcomes under different greenhouse gas emission trajectories. Unlike many previous ecological studies, the analysis evaluates simultaneous exposure to multiple hazards, producing a more comprehensive assessment of future ecological vulnerability.

The maps presented in the paper reveal particularly high vulnerability in tropical regions, biodiversity hotspots, and mountainous ecosystems, where many species possess limited geographical ranges and restricted opportunities for migration. The results indicate that climate mitigation substantially influences ecological outcomes. Under high-emission scenarios, the proportion of terrestrial vertebrates exposed to multiple concurrent climate extremes increases dramatically by 2085, whereas ambitious emission reductions significantly lessen cumulative exposure. Amphibians emerge as among the most vulnerable groups because of their narrow environmental tolerances and dependence on stable moisture conditions. Species with restricted distributions also face disproportionately high risks.

Although the authors acknowledge uncertainties associated with climate projections and assumptions about species' dispersal capacities, they argue that their multi-hazard framework provides a more realistic representation of future ecological risk than traditional single-threat assessments. They recommend expanding future research to incorporate ecological interactions, behavioral adaptation, and evolutionary responses, which may either amplify or buffer projected impacts. Overall, the study demonstrates that biodiversity conservation must prepare not only for a warmer planet but also for an increasingly unpredictable one, where the accumulation of multiple climate extremes may become the defining challenge for wildlife persistence during the coming decades.

Future biodiversity will be influenced by both gradual climate warming and the interaction of heatwaves, droughts, floods, wildfires, and tropical cyclones.

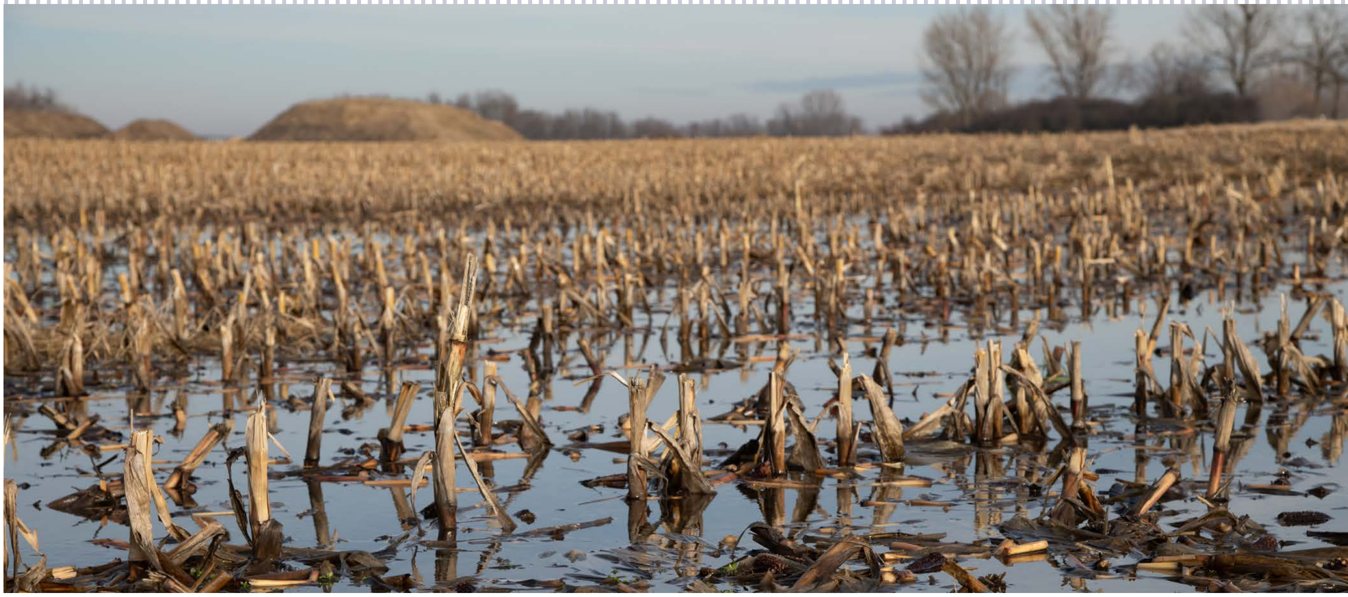
Biodiversity conservation must prepare for a warmer and increasingly unpredictable planet.

Prospective research

Europe's Forest Futures Through a Megatrend Lens: Mapping the Drivers of Change Across a Continent

Langenbacher, J., Levering, A., & Verburg, P. H. (2025). Mapping megatrends shaping European forests. Sustainability Science

Langenbacher, Levering, and Verburg (2025) develop a continental-scale framework to understand how multiple interacting "megatrends" are reshaping European forests under accelerating environmental and socio-economic change.



Rather than focusing on a single driver such as climate change, the authors argue that forest futures emerge from the combined influence of several pressures acting simultaneously across space and time. As they emphasize, "European forests are changing rapidly due to environmental pressures and human actions, making it essential to understand the drivers and their potential impacts for informing management and policy". The study is explicitly prospective, aiming to map future-oriented pressures rather than simply describe historical disturbance patterns.

The authors quantify and spatially map six major megatrends affecting European forests: climate change, fire regimes, pests and pathogens, forest cover and felling intensity change, harvesting, and pollution and nutrient enrichment. These drivers are operationalized using a wide range of observational datasets and modeled projections, including climate simulations, remote sensing products, forest disturbance records, and integrated assessment models. The analysis is conducted at a high spatial resolution across Europe, enabling the identification of regional "hotspots" where multiple pressures overlap and potentially reinforce each other.

A key finding is that megatrends rarely operate in isolation. Instead, they cluster spatially into distinct "archetypes" of forest pressure. Hotspots are particularly evident in northern boreal forests and mountainous regions, where climate warming, pest outbreaks, and intensified harvesting interact. The study identifies two dominant pressure combinations: a warming-driven northern cluster with intensified forestry, and a temperate European cluster strongly affected by bark beetle outbreaks. These patterns suggest that Europe's forests are entering an era of compound stress, where multiple drivers reinforce one another rather than acting independently.

The results also show that management intensity varies widely across Europe, with highly managed plantation systems in Nordic and Atlantic regions contrasting with more mixed-use forests elsewhere. This heterogeneity means that future ecological outcomes will be strongly shaped by regional policy choices. The authors call for improved high-resolution monitoring data and more realistic modeling of interacting pressures, as well as stronger alignment between ecological science and forest policy. Overall, the paper provides a foundational framework for anticipating how multiple global change drivers will jointly shape the future of Europe's forests ecosystems.

Six major megatrends affecting European forests are climate change, fire regimes, pests and pathogens, changes in forest cover and felling intensity, harvesting, and pollution and nutrient enrichment.

Rights-based data practices should treat refugees as active stakeholders, prioritizing dignity, agency, and justice.

Prospective research

Forecasting Tomorrow's Forests: Predicting Europe's Vegetation in a Changing Climate

Projections of current and future European potential vegetation types. (2025). Ecological Informatics, 91, 103418.

Projections of Current and Future European Potential Vegetation Types (2025) presents a comprehensive prospective assessment of how climate change is expected to transform the distribution of Europe's natural vegetation during the twenty-first century.

Rather than examining individual plant species, the study focuses on potential vegetation types, representing the plant communities that would naturally occur under specific climatic conditions in the absence of significant human disturbance. This ecosystem-level perspective enables the researchers to evaluate how changing temperature and precipitation patterns may reshape entire landscapes, providing valuable information for biodiversity conservation, ecological restoration, and long-term land-use planning.

The authors employ Bayesian statistical modeling combined with high-resolution climate projections to estimate future vegetation distributions across Europe under multiple climate scenarios. Bayesian methods are particularly suitable for ecological forecasting because they explicitly incorporate uncertainty into model predictions while integrating information from multiple environmental variables. Future projections are based on contemporary climate simulations extending to the end of the century, allowing comparisons between present-day vegetation patterns and those expected under continued global warming. By modeling vegetation as dynamic ecological systems rather than static landscape features, the study captures the complexity of future ecosystem transitions.

Figures presented in the article demonstrate a clear northward expansion of Mediterranean and temperate vegetation types, accompanied by substantial contractions of boreal forests and alpine ecosystems. The visual evidence highlights that climate change is expected to reorganize Europe's ecological landscapes rather than simply alter the abundance of existing vegetation.

The modeling results suggest that warmer and drier conditions will promote the spread of vegetation adapted to higher temperatures, while ecosystems dependent on cool or moist climates become increasingly restricted. Although the Bayesian modeling framework effectively quantifies predictive uncertainty, the authors acknowledge limitations associated with future climate projections and the exclusion of factors such as land-use change, species dispersal, and ecological interactions. They recommend integrating these variables into future modeling efforts to improve ecological forecasting and support adaptive environmental management. Overall, the study demonstrates that Europe's future vegetation will likely differ substantially from that of today, reinforcing the need for conservation strategies that anticipate ecological transformation rather than attempting to preserve historical landscape conditions.

By modeling vegetation as dynamic ecological systems rather than static landscape features, the complexity of future ecosystem transitions can be captured.

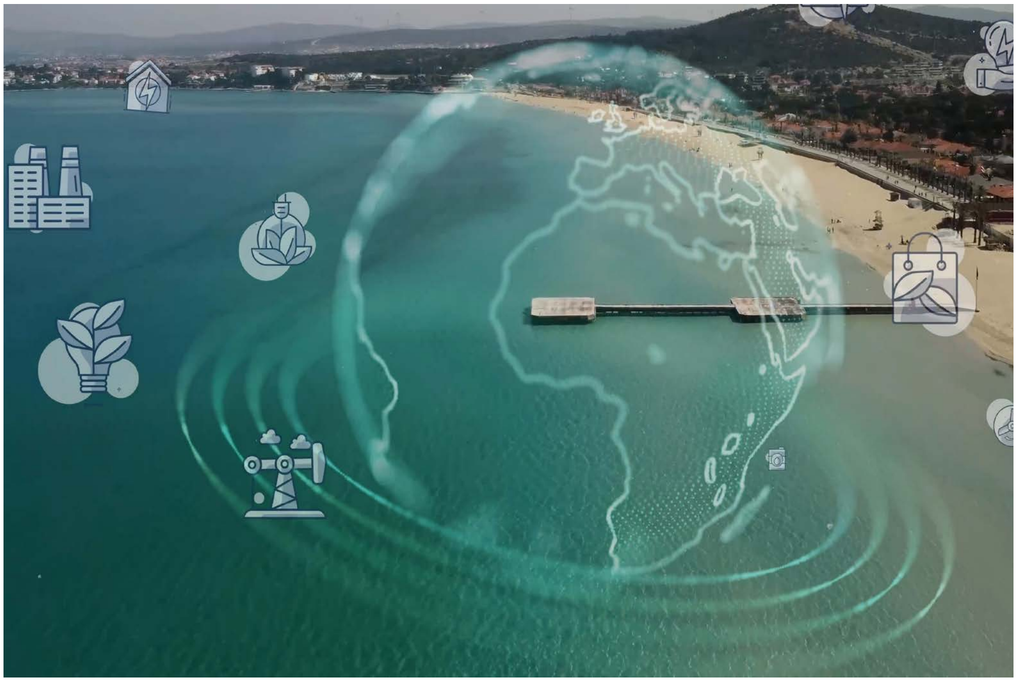
Modeling shows a clear northward shift of Mediterranean and temperate vegetation, with significant declines in boreal forests and alpine ecosystems.

2 Applied research

Smarter Shores: How Artificial Intelligence Is Transforming Coastal Environmental Monitoring

Sun, H., & Zheng, X. (2026). An AI-driven framework for coastal city monitoring via deep learning and earth observation. Frontiers in Environmental Science, 13, 1688417. 7

Sun and Zheng (2026) present an innovative artificial intelligence framework designed to improve environmental monitoring in coastal cities, where rapid urbanization, climate change, and ecological degradation create increasingly complex management challenges.



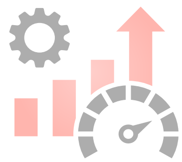
Coastal environments are highly dynamic systems in which tides, pollution, weather, and human activities continuously interact, making conventional monitoring approaches difficult to maintain. Traditional remote sensing techniques often rely on static sensor networks or predefined analytical rules, limiting their ability to respond to rapidly changing environmental conditions. To overcome these limitations, the authors propose an adaptive AI-based system that integrates deep learning, Earth observation data, and intelligent sensor management into a unified environmental monitoring platform. As they note, their objective is to provide "a comprehensive and adaptable solution for environmental management in rapidly evolving coastal urban areas."

The proposed framework combines satellite imagery, fixed environmental sensors, mobile sensing platforms, and meteorological information using a novel Maritime Adaptive Graph Sensing Network (MAGSNet). Unlike conventional machine-learning models that process observations independently, MAGSNet represents monitoring locations as interconnected nodes within a dynamic graph, allowing the system to learn how environmental conditions evolve across both space and time. The researchers further introduce a Multi-Resolution Spatio-Temporal Prioritization (MRSTP) module that intelligently allocates sensing resources to areas where uncertainty or environmental variability is greatest. This adaptive strategy enables the system to maintain high monitoring accuracy while reducing unnecessary data collection, bandwidth use, and energy consumption. The model was evaluated using multiple benchmark coastal datasets alongside field observations collected from the Port of Shenzhen.

Experimental results demonstrate substantial improvements over existing approaches. Across several benchmark datasets, the proposed model achieved up to 3.2 times higher F1 scores and approximately 4% higher area under the curve (AUC) than state-of-the-art baseline methods while simultaneously improving resource efficiency.

The authors acknowledge that future implementations should incorporate additional socio-economic variables such as population density, infrastructure vulnerability. They also recommend closer collaboration with policymakers and local authorities to ensure that AI-generated predictions translate into practical management strategies. Overall, the study demonstrates how applied artificial intelligence can move beyond automated data analysis to become an adaptive environmental management tool capable of supporting resilient coastal cities in the face of accelerating climate and urban change.

MAGSNet represents monitoring locations as interconnected nodes within a dynamic graph, allowing the system to learn how environmental conditions evolve across both space and time.



They rely on family, friendship, culture, faith, community, arts, sports, and education to cope with adversity.

Applied research

Teaching Artificial Intelligence to See Disaster: Deep Learning for Faster Environmental Hazard Assessment

Sahu, M., & Dash, R. (2025). A deep classification model to assess environment following hazards using remote sensing images. Discover Applied Sciences, 7, Article 768.

Sahu and Dash (2025) present an applied artificial intelligence model designed to improve environmental hazard assessment through the automated analysis of remote sensing imagery. Natural disasters such as floods, landslides, earthquakes, and wildfires often alter landscapes rapidly, making timely damage assessment essential for effective emergency response and environmental recovery.

Conventional image interpretation relies heavily on manual analysis by experts, a process that is both time-consuming and susceptible to human error when large geographical areas are involved. To address these limitations, the authors develop a deep learning classification model capable of rapidly identifying environmental changes from satellite images, demonstrating how artificial intelligence can support faster and more accurate post-disaster decision-making. As the authors argue, integrating AI with remote sensing can significantly enhance environmental monitoring by reducing the time required to detect and classify hazard-affected areas.

The proposed methodology combines image preprocessing techniques with a convolutional neural network (CNN) architecture specifically designed for environmental image classification. Satellite images are first enhanced and standardized before being processed by the deep learning model, which automatically extracts spatial features associated with different types of environmental damage. The model is trained and validated using publicly available remote sensing datasets representing multiple hazard scenarios, allowing the researchers to evaluate its performance against existing machine learning approaches. Unlike traditional classification methods that require manual feature extraction, the CNN independently learns relevant image characteristics, improving both efficiency.

Experimental findings indicate that the proposed CNN outperforms several established machine learning models in classifying hazard-related environmental changes. This improved accuracy allows damaged landscapes to be identified more rapidly, enabling emergency managers and environmental agencies to prioritize response efforts and reduce delays associated with manual interpretation. The authors emphasize that AI-assisted image analysis is particularly valuable when disasters affect large or inaccessible regions where field surveys are impractical.

Although the model demonstrates strong performance, the authors acknowledge limitations related to dataset diversity and the generalization of results across different geographic regions and hazard types. They recommend expanding future research by incorporating larger international datasets, integrating real-time satellite observations, and exploring hybrid deep learning architectures capable of handling increasingly complex environmental conditions. Overall, the study demonstrates that applied artificial intelligence has considerable potential to strengthen environmental hazard assessment, providing faster, more consistent, and scalable analyses that can improve disaster response, ecological recovery, and long-term environmental management.

Integrating AI with remote sensing significantly enhances environmental monitoring.

AI-assisted image analysis is invaluable for assessing disasters in large or inaccessible areas where field surveys are impractical.

Applied research

Seeing the Planet Through Artificial Intelligence: The Next Frontier of Environmental Remote Sensing

Maniyar, C. B., Yan, X., Mai, G., Srivastava, D., Samiappan, S., Oliazadeh, A., Kumar, A., Kumar, M., & Mishra, D. R. (2025). Artificial intelligence in environmental remote sensing: Progress, way forward and key considerations. Progress in Environmental Geography, 4(3), 363–389.

Maniyar et al. (2025) examine how artificial intelligence (AI) is transforming environmental remote sensing (ERS), arguing that the combination of machine learning (ML), deep learning (DL), and Earth observation technologies is reshaping how scientists monitor ecosystems and address environmental challenges.

The authors contend that traditional remote sensing techniques, although highly effective for collecting environmental data, often struggle to process the enormous volume and complexity of modern satellite imagery. AI addresses this limitation by enabling the rapid analysis of large datasets and identifying spatial and temporal patterns that would be difficult to detect using conventional methods. As the authors state, AI offers "robust, data-driven solutions for analyzing complex, large-scale remote sensing datasets," making it an increasingly essential tool for environmental science.

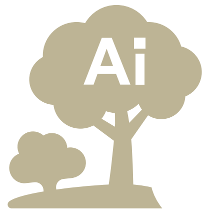
Rather than focusing on a single application, the paper synthesizes recent advances across four major environmental domains: water quality monitoring, agriculture, urban environments, and wetlands. The authors explain how convolutional neural networks, transformer models, and foundation models are being used to classify land cover, detect harmful algal blooms, estimate crop productivity, monitor urban expansion, and assess wetland degradation. These technologies significantly improve the speed and accuracy of environmental assessments while reducing dependence on manual image interpretation. The review also introduces emerging geospatial foundation models capable of learning from massive Earth observation datasets, allowing AI systems to generalize across multiple environmental applications rather than being trained for individual tasks.

The review also addresses important challenges associated with implementing AI in environmental science. The authors identify limited labeled datasets, model interpretability, computational costs, and ethical concerns surrounding transparency and responsible AI as significant barriers to broader adoption. They emphasize that highly accurate predictions alone are insufficient if decision-makers cannot understand how AI reaches its conclusions or trust its outputs in environmental management contexts. Consequently, the paper advocates for explainable AI, open data practices, and interdisciplinary collaboration between environmental scientists, geographers.

Looking ahead, Maniyar et al. conclude that future environmental remote sensing will increasingly rely on foundation models, multimodal learning, and responsible AI frameworks capable of integrating satellite imagery, sensor networks. They recommend developing standardized datasets, improving model transparency, and strengthening ethical governance to ensure AI contributes effectively to sustainable environmental management.

Overall, the paper demonstrates that artificial intelligence is not replacing environmental science but expanding its capacity to monitor, understand, and manage rapidly changing ecosystems.

AI provides robust, data-driven solutions for analyzing complex, large-scale remote sensing datasets.



Limited labeled datasets, model interpretability, computational costs, and transparency concerns as the main barriers to AI adoption in environmental science.

Applied research

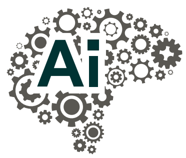
From Citizens to Algorithms: How AI Is Reshaping Participatory Environmental Governance

Santos, M. R. C., & Carvalho, L. C. (2025). AI-driven participatory environmental management: Innovations, applications, and future prospects. Journal of Environmental Management, 373, 123864

Santos and Carvalho (2025) examine how artificial intelligence (AI) is transforming participatory environmental management by enabling new forms of stakeholder engagement, data integration, and decision support in environmental governance.

The study responds to a growing challenge in sustainability science: while environmental problems are increasingly complex and data-rich, traditional participatory processes often struggle to incorporate large-scale information flows and diverse stakeholder perspectives in a timely and structured way. Methodologically, the study is a systematic literature-based analysis combining bibliometric techniques with AI-assisted text mining. This approach enables the structuring of a rapidly expanding and fragmented research field into coherent thematic clusters. The study highlights key domains where AI is currently being applied, including participatory geographic information systems (PGIS), environmental monitoring, disaster risk management, smart agriculture, and public engagement platforms. A central finding is that AI is increasingly being used not only for prediction and monitoring but also for facilitating communication between institutions and citizens through tools such as chatbots and digital platforms that enable real-time environmental reporting. One of the key visual outputs of the study is a cluster-based thematic map of the literature, which identifies major research groupings such as governance and climate resilience, community-integrated resource management, precision environmental monitoring, and smart infrastructure systems. These clusters illustrate that AI in environmental management is not a single application domain but a multi-layered ecosystem of tools and practices. Another key figure synthesizes future research directions, showing strong convergence around four priorities: AI governance and regulation, technological innovation, sustainability and ethics, and interdisciplinary collaboration. The results show that AI is increasingly embedded in environmental decision-making systems through applications such as predictive modeling of environmental risks, optimization of resource management, and real-time monitoring of ecological indicators. Importantly, The paper concludes that future research must focus on developing ethical, transparent, and inclusive AI systems that enhance rather than replace human participation in environmental governance. The authors recommend stronger regulatory frameworks, improved interoperability between AI systems and environmental datasets, and deeper integration of interdisciplinary expertise to ensure responsible innovation. Overall, Santos and Carvalho (2025) demonstrate that AI is not merely a technical tool in environmental management but a structural force reshaping how participation, governance, and sustainability are conceptualized and operationalized in contemporary environmental systems.

AI is increasingly being used not only for prediction and monitoring but also for facilitating communication.



Future research should advance ethical, transparent, and inclusive AI to support human participation in environmental governance.

Applied research

Reading Policies with Machines: How AI Reveals Hidden Power Structures in Wastewater Governance

Leeuwerik, R. N. C. (2025). Tracing prescribed knowledge flows in wastewater management policies: An AI-assisted, governmentality-informed framework with insights from Indonesia. Environmental Management, 75, 3461–3478.

Leeuwerik (2025) develops an innovative applied framework that uses AI to analyze how environmental governance is structured through policy documents, focusing specifically on wastewater management in Indonesia.

Rather than treating policy as neutral or purely administrative text, the study investigates how policies encode "prescribed knowledge flows"—that is, how information, responsibility, and authority are expected to move between actors such as governments, communities, and technical agencies. The central argument is that environmental governance is shaped not only by formal institutions but also by the way knowledge is structured, distributed, and operationalized within policy language. To uncover these patterns, the author combines a governmentality perspective with AI-assisted text analysis, demonstrating how computational tools can support critical policy interpretation. Methodologically, the study applies a qualitative document analysis enhanced by a custom AI prompt designed to detect and extract knowledge flows from policy texts. These outputs are then manually verified and coded, allowing the researcher to identify who is expected to generate knowledge, who receives it, and how it is used in governance processes. A key visual contribution of the paper is the conceptual framework outlining four dimensions of "regimes of practice," which structure how governance operates through knowledge. These include ways of seeing, ways of knowing, forms of identity, and techniques of government. The framework shows how wastewater governance is not only about infrastructure and regulation but also about shaping behavior, assigning responsibility, and defining what counts as valid environmental knowledge.

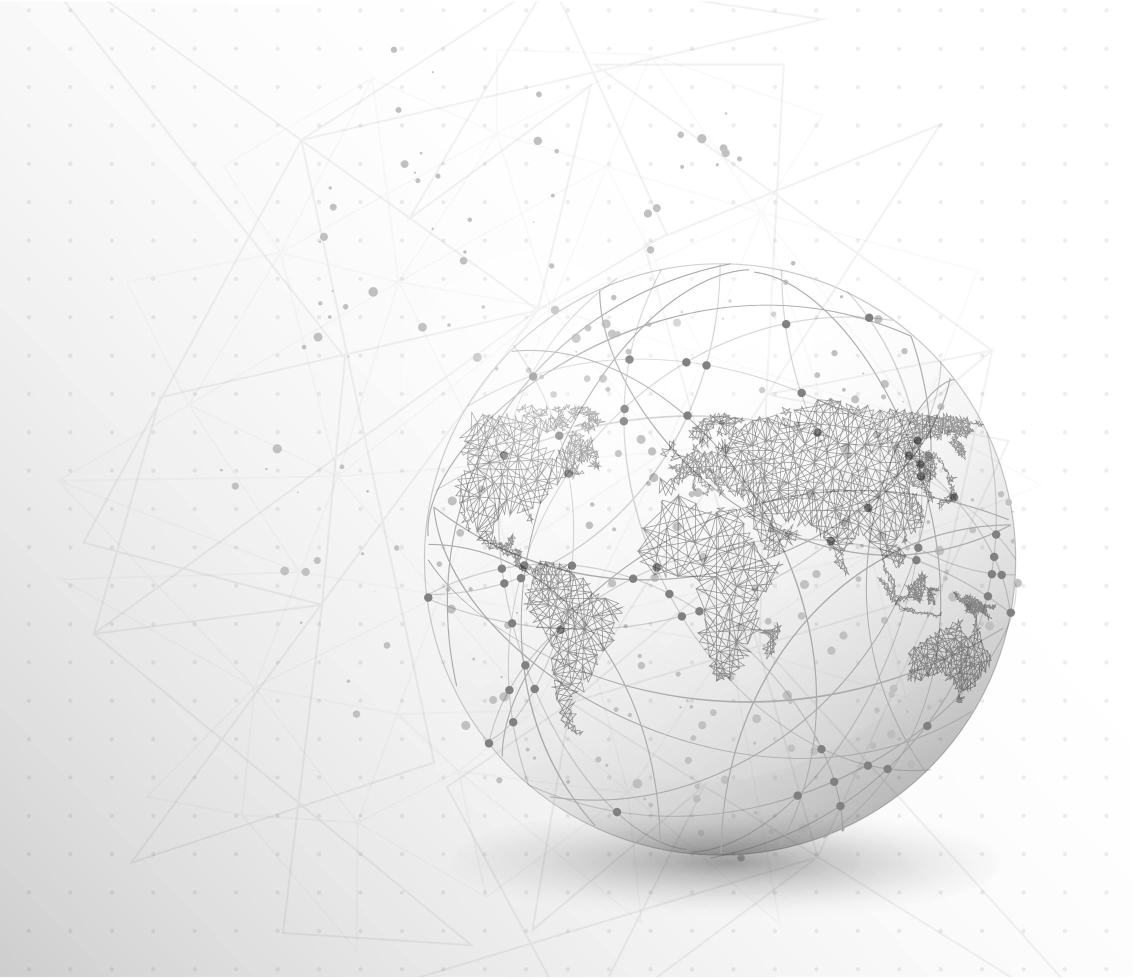
Policies often frame local actors as key agents responsible for implementation, while higher-level institutions provide guidance and regulatory frameworks. However, the study identifies a significant gap between policy intention and operational clarity. Many documents lack detailed explanations of stakeholder responsibilities, resource allocation, or enforcement mechanisms. This creates ambiguity in implementation and may shift accountability downward without sufficient institutional support.

The study concludes that combining governmentality theory with AI-based text analysis offers a powerful approach for understanding environmental governance systems. It enables researchers to uncover hidden assumptions embedded in policy documents and to critically assess how environmental responsibility is distributed across institutions and society. Ultimately, Leeuwerik (2025) demonstrates that AI can be used not only for prediction or monitoring, but also as a tool for critical environmental policy analysis, revealing how governance systems shape knowledge, behavior, and environmental outcomes.

Indonesian wastewater governance is strongly oriented toward decentralization and community participation.

AI can serve not only for prediction and monitoring but also as a vital tool for analyzing crucial environmental policies.

3 The future in numbers

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Portugal
Senegal
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Jordan
Cape Verde
DR Congo
Ecuador
Haiti
Iran
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7Saber
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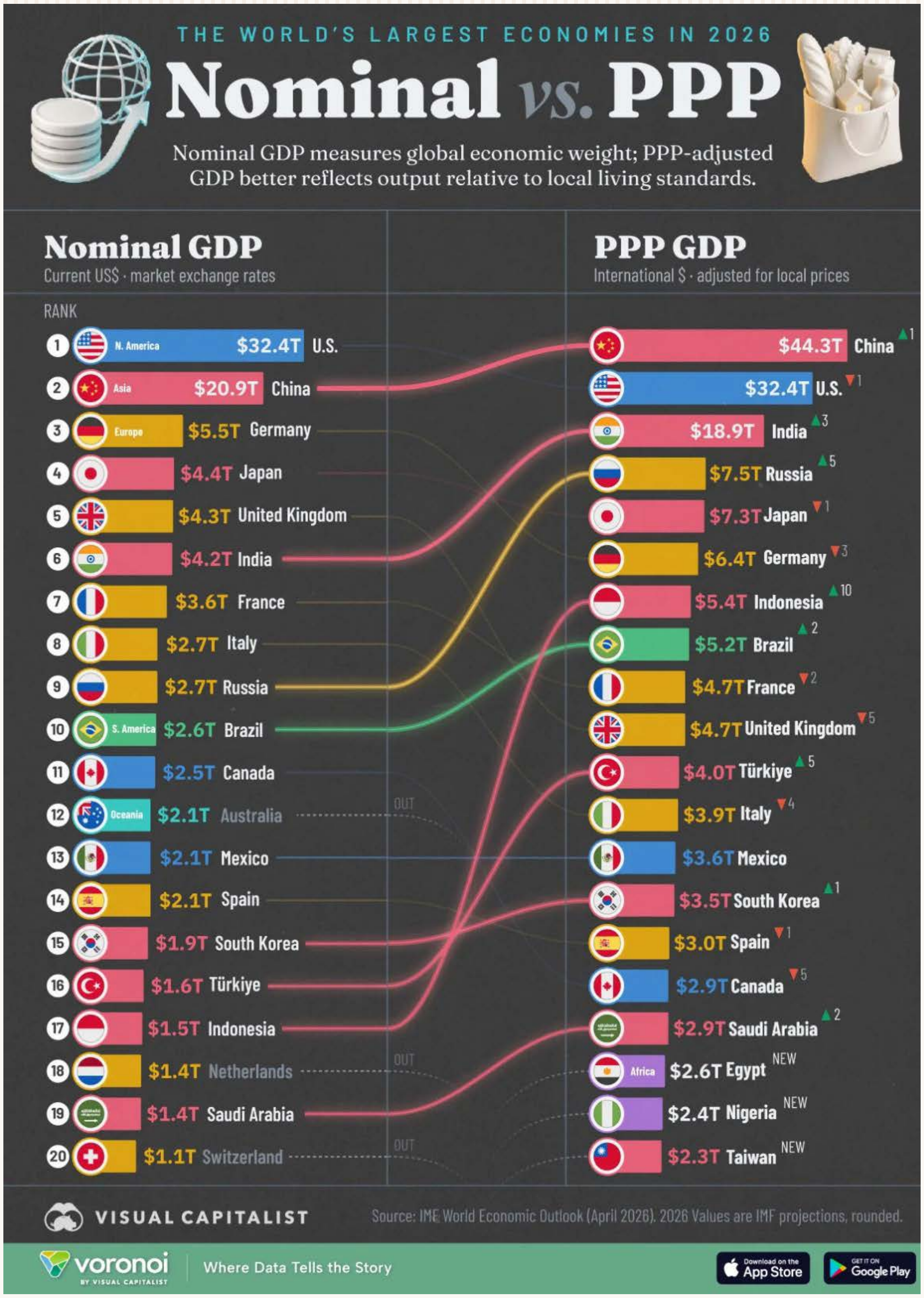
Data Source: Tonton Sportswear


THE WORLD'S LARGEST ECONOMIES IN 2026
Nominal vs. PPP
Nominal GDP measures global economic weight; PPP-adjusted GDP better reflects output relative to local living standards.
Nominal GDP
Current US$ · market exchange rates
PPP GDP
International $ · adjusted for local prices
RANK
1 N. America $32.4T U.S.
2 Asia $20.9T China
3 Europe $5.5T Germany
4 $4.4T Japan
5 $4.3T United Kingdom
6 $4.2T India
7 $3.6T France
8 $2.7T Italy
9 $2.7T Russia
10 S. America $2.6T Brazil
11 $2.5T Canada
12 Oceania $2.1T Australia
13 $2.1T Mexico
14 $2.1T Spain
15 $1.9T South Korea
16 $1.6T Türkiye
17 $1.5T Indonesia
18 $1.4T Netherlands
19 $1.4T Saudi Arabia
20 $1.1T Switzerland
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$32.4T U.S. ▼1
$18.9T India ▲3
$7.5T Russia ▲5
$7.3T Japan ▼1
$6.4T Germany ▼3
$5.4T Indonesia ▲10
$5.2T Brazil ▲2
$4.7T France ▼2
$4.7T United Kingdom ▼5
$4.0T Türkiye ▲5
$3.9T Italy ▼4
$3.6T Mexico
$3.5T South Korea ▲1
$3.0T Spain ▼1
$2.9T Canada ▼5
$2.9T Saudi Arabia ▲2
Africa $2.6T Egypt NEW
$2.4T Nigeria NEW
$2.3T Taiwan NEW
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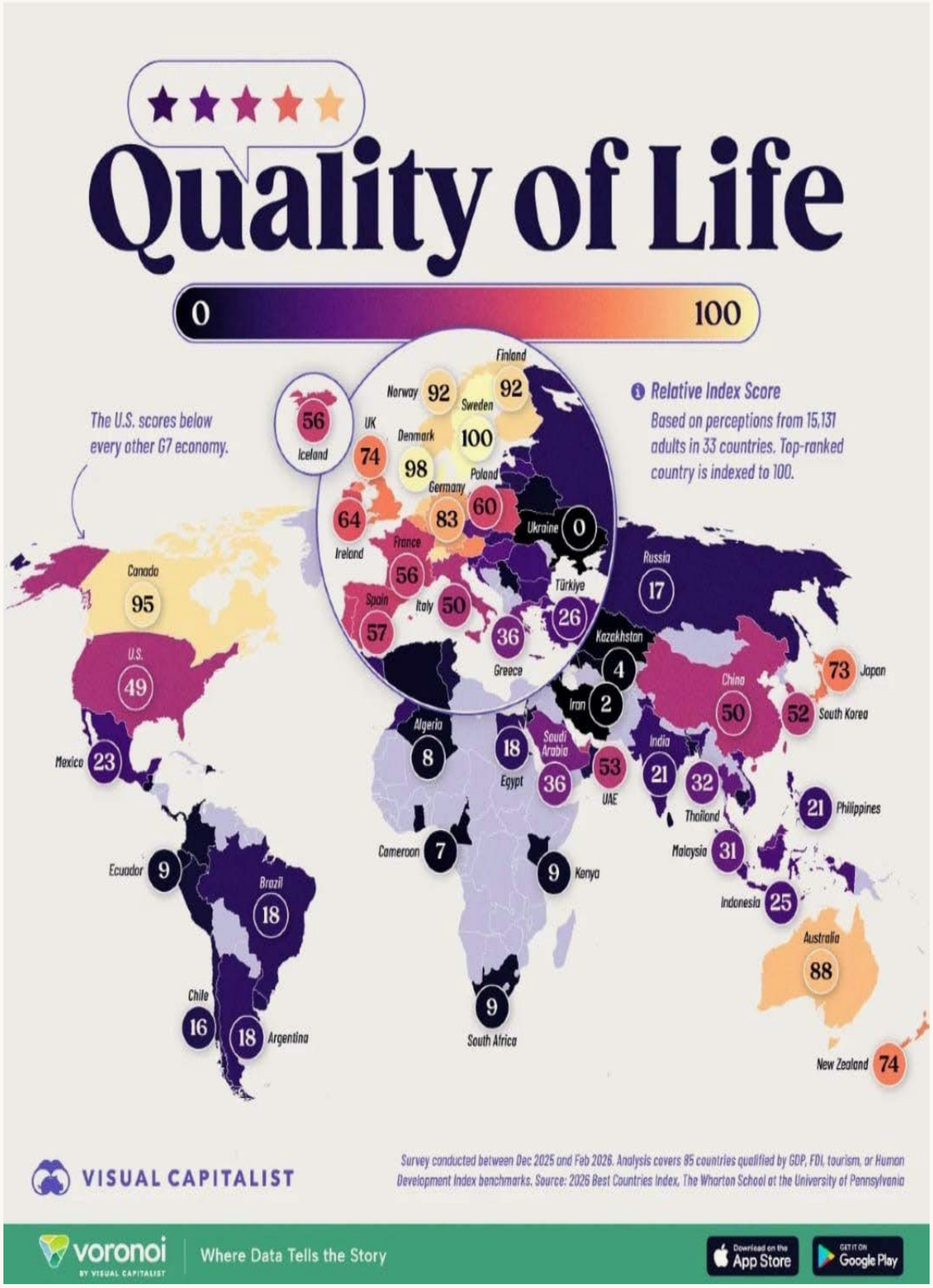
Quality of Life
0
100
The U.S. scores below every other G7 economy.
Relative Index Score
Based on perceptions from 15,131 adults in 33 countries. Top-ranked country is indexed to 100.
Iceland 56
Norway 92
Finland 92
Sweden 100
UK 74
Denmark 98
Poland 60
Germany 83
Ireland 64
Ukraine 0
France 56
Spain 57
Italy 50
Türkiye 26
Greece 36
Russia 17
Canada 95
U.S. 49
Mexico 23
Kazakhstan 4
Iran 2
China 50
Japan 73
South Korea 52
Algeria 8
Egypt 18
Saudi Arabia 36
UAE 53
India 21
Thailand 32
Philippines 21
Malaysia 31
Indonesia 25
Cameroon 7
Kenya 9
Ecuador 9
Brazil 18
Chile 16
Argentina 18
South Africa 9
Australia 88
New Zealand 74
VISUAL CAPITALIST
Survey conducted between Dec 2025 and Feb 2026. Analysis covers 85 countries qualified by GDP, FDI, tourism, or Human Development Index benchmarks. Source: 2026 Best Countries Index, The Wharton School at the University of Pennsylvania
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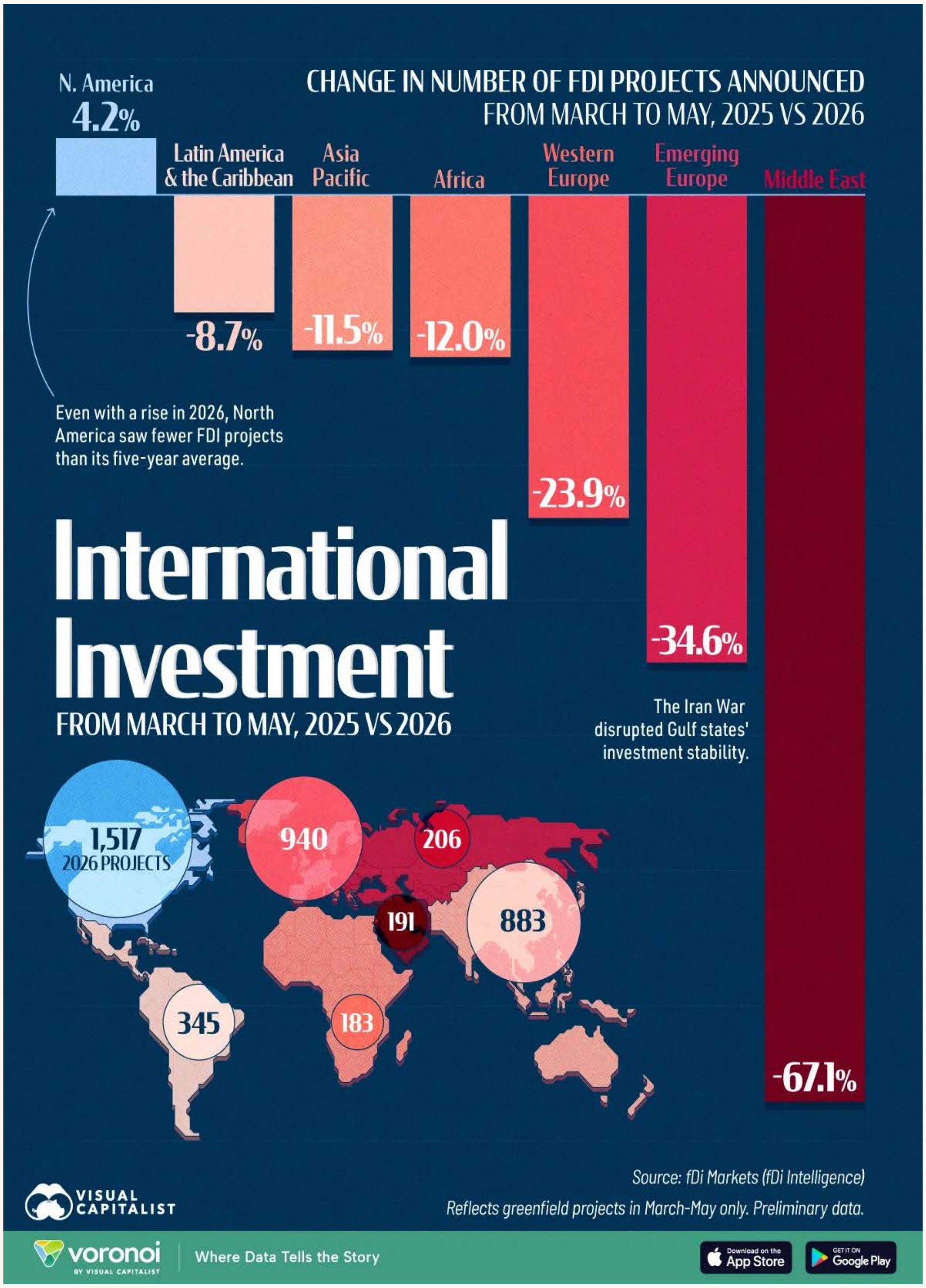
CHANGE IN NUMBER OF FDI PROJECTS ANNOUNCED
FROM MARCH TO MAY, 2025 VS 2026
N. America
4.2%
Latin America & the Caribbean
-8.7%
Asia Pacific
-11.5%
Africa
-12.0%
Western Europe
-23.9%
Emerging Europe
-34.6%
Middle East
-67.1%
Even with a rise in 2026, North America saw fewer FDI projects than its five-year average.
International Investment
FROM MARCH TO MAY, 2025 VS 2026
The Iran War disrupted Gulf states' investment stability.
1,517
2026 PROJECTS
940
206
191
883
345
183
Source: fDi Markets (fDi Intelligence)
Reflects greenfield projects in March-May only. Preliminary data.
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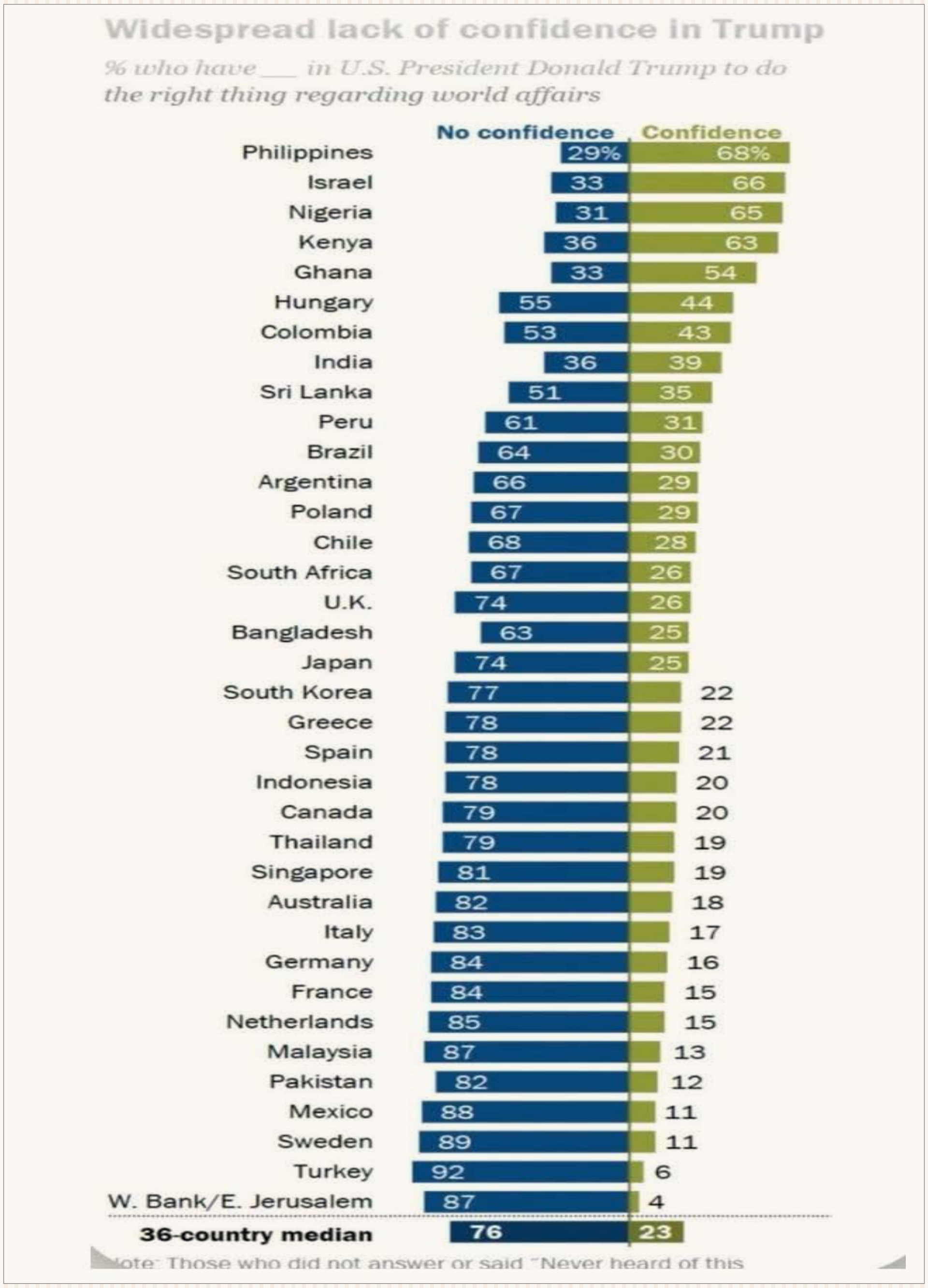
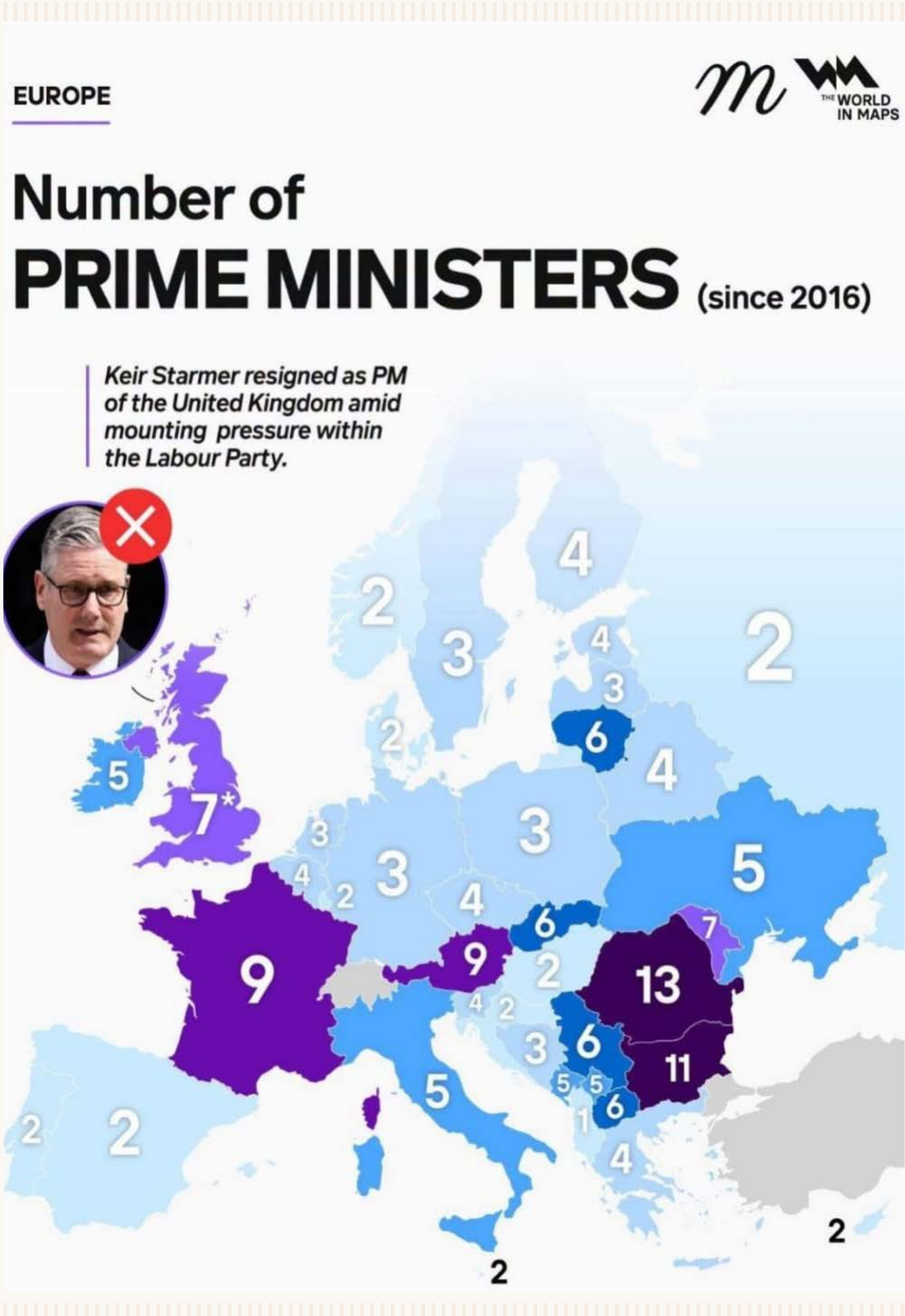
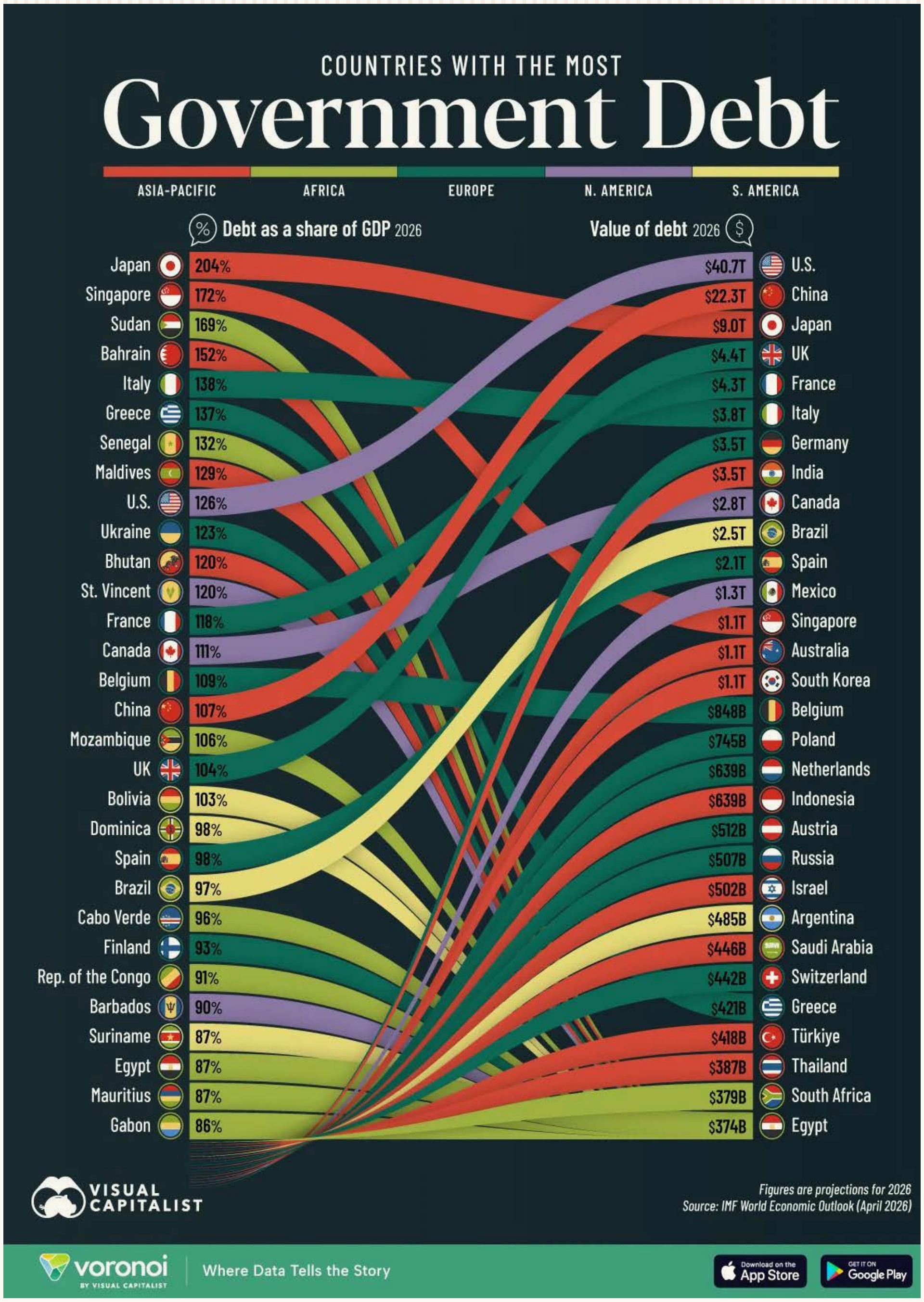

Widespread lack of confidence in Trump
% who have ___ in U.S. President Donald Trump to do the right thing regarding world affairs
No confidence
Confidence
Philippines 29% 68%
Israel 33 66
Nigeria 31 65
Kenya 36 63
Ghana 33 54
Hungary 55 44
Colombia 53 43
India 36 39
Sri Lanka 51 35
Peru 61 31
Brazil 64 30
Argentina 66 29
Poland 67 29
Chile 68 28
South Africa 67 26
U.K. 74 26
Bangladesh 63 25
Japan 74 25
South Korea 77 22
Greece 78 22
Spain 78 21
Indonesia 78 20
Canada 79 20
Thailand 79 19
Singapore 81 19
Australia 82 18
Italy 83 17
Germany 84 16
France 84 15
Netherlands 85 15
Malaysia 87 13
Pakistan 82 12
Mexico 88 11
Sweden 89 11
Turkey 92 6
W. Bank/E. Jerusalem 87 4
36-country median 76 23


EUROPE
THE WORLD IN MAPS
Number of
PRIME MINISTERS (since 2016)
Keir Starmer resigned as PM of the United Kingdom amid mounting pressure within the Labour Party.
7*
5
9
2
2
3
4
2
3
6
4
2
3
3
4
2
3
4
5
6
9
7
2
13
4
2
3
6
11
5
5
5
6
1
4
2
2



COUNTRIES WITH THE MOST
Government Debt
ASIA-PACIFIC
AFRICA
EUROPE
N. AMERICA
S. AMERICA
Debt as a share of GDP 2026
Value of debt 2026
Japan 204%
Singapore 172%
Sudan 169%
Bahrain 152%
Italy 138%
Greece 137%
Senegal 132%
Maldives 129%
U.S. 126%
Ukraine 123%
Bhutan 120%
St. Vincent 120%
France 118%
Canada 111%
Belgium 109%
China 107%
Mozambique 106%
UK 104%
Bolivia 103%
Dominica 98%
Spain 98%
Brazil 97%
Cabo Verde 96%
Finland 93%
Rep. of the Congo 91%
Barbados 90%
Suriname 87%
Egypt 87%
Mauritius 87%
Gabon 86%
$40.7T U.S.
$22.3T China
$9.0T Japan
$4.4T UK
$4.3T France
$3.8T Italy
$3.5T Germany
$3.5T India
$2.8T Canada
$2.5T Brazil
$2.1T Spain
$1.3T Mexico
$1.1T Singapore
$1.1T Australia
$1.1T South Korea
$848B Belgium
$745B Poland
$639B Netherlands
$639B Indonesia
$512B Austria
$507B Russia
$502B Israel
$485B Argentina
$446B Saudi Arabia
$442B Switzerland
$421B Greece
$418B Türkiye
$387B Thailand
$379B South Africa
$374B Egypt
VISUAL CAPITALIST
Figures are projections for 2026
Source: IMF World Economic Outlook (April 2026)
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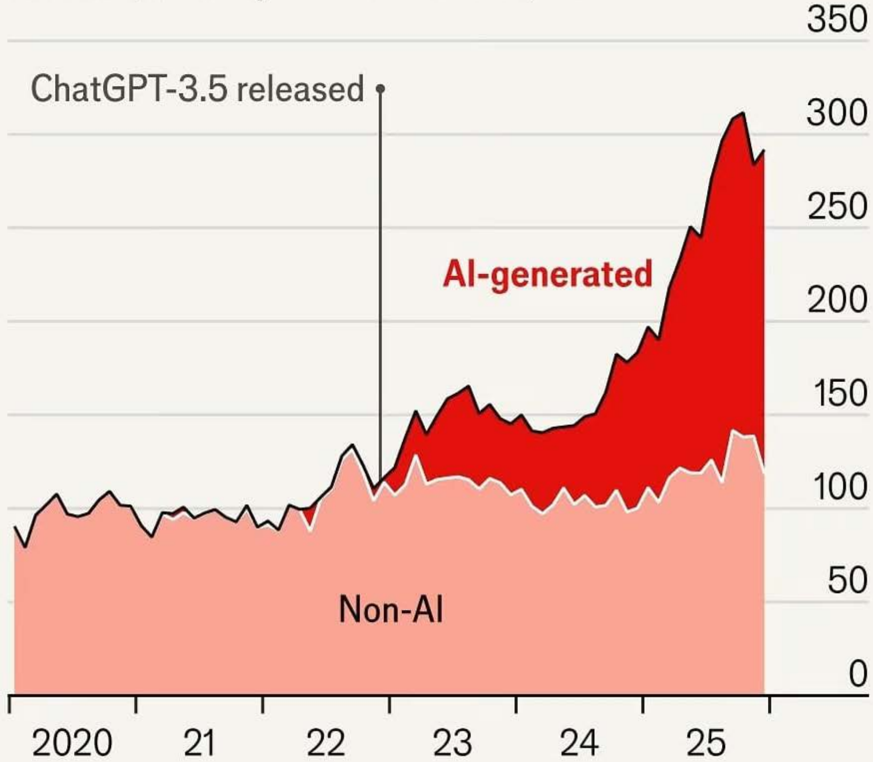
AI-generated books are on the rise

Amazon, monthly e-book releases, ’000



Source: “AI and the quantity and quality of creative products: have LLMs boosted creation of valuable books?”, by I. Reimers and J. Waldfogel, 2026


U.S. COMPANIES $1.0T
THE WORLD'S 30 MOST
Profitable Companies
BY COUNTRY IN 2026
$160B
ANNUAL PROFITS IN USD
Alphabet
$125B
Microsoft
$123B
Apple
$120B
NVIDIA
$71B
Meta
$59B
JPMorganChase
$91B
amazon
$32B
BANK OF AMERICA
$25B
ExxonMobil
$25B
Lilly
$25B
BROADCOM
$24B
micron
$72B
BERKSHIRE HATHAWAY INC.
$22B
VISA
$22B
WELLS FARGO
$22B
Walmart
OTHER COMPANIES $605B
$51B
ICBC
$48B
中国建设银行
China Construction Bank
$39B
中国农业银行
AGRICULTURAL BANK OF CHINA
$35B
中国银行
BANK OF CHINA
$33B
Tencent 腾讯
$22B
PetroChina
$22B
中国人寿
CHINA LIFE
$58B
SAMSUNG
$53B
SK hynix
$99B
أرامكو السعودية
saudi aramco
$62B
tsmc
$33B
SoftBank
$26B
TOYOTA
$24B
SNB BNS
VISUAL CAPITALIST
Latest-12 months' financial data as of May 2026 cutoff
Source: Forbes The Global 2000
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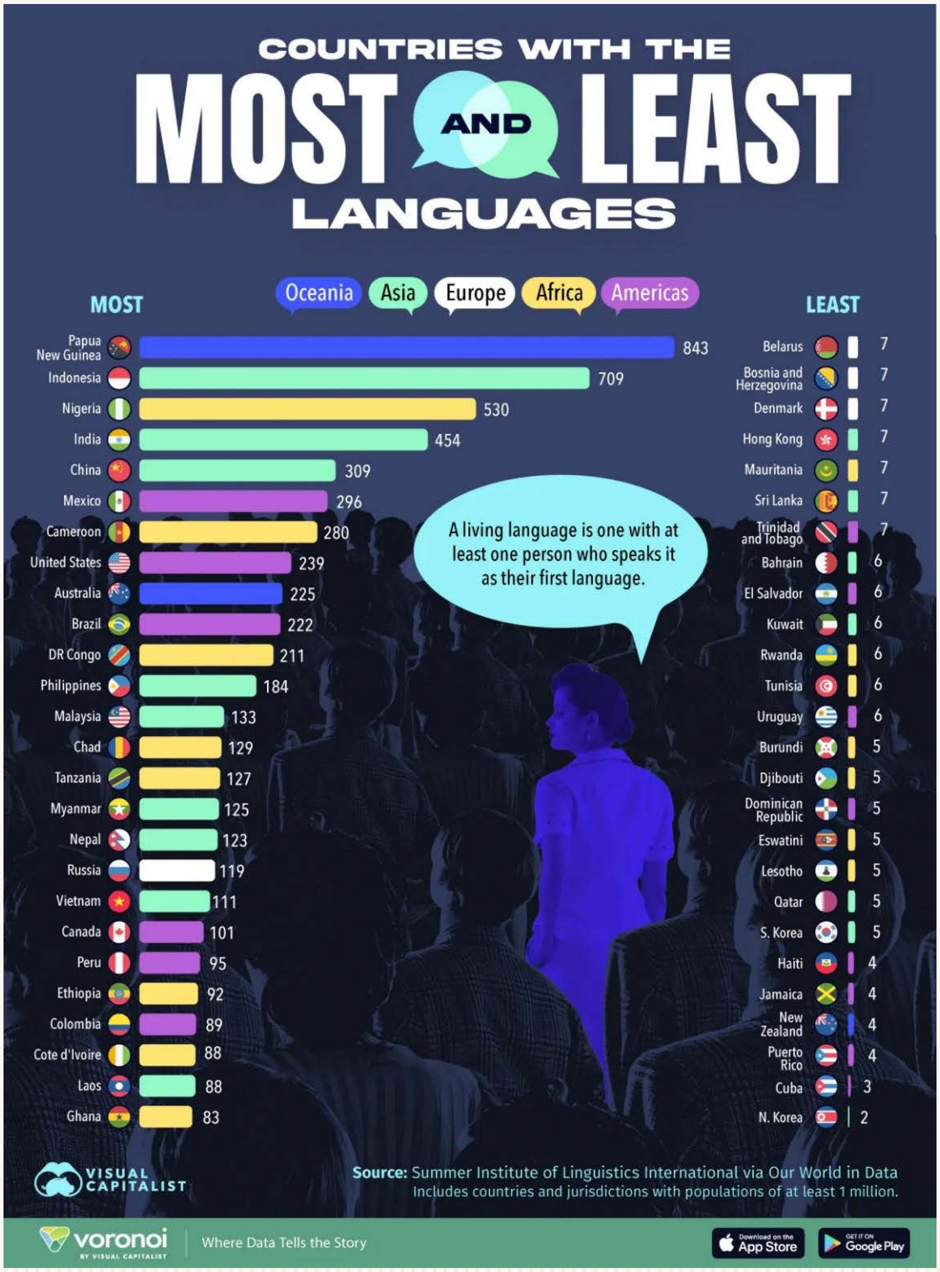
COUNTRIES WITH THE
MOST AND LEAST
LANGUAGES
Oceania
Asia
Europe
Africa
Americas
MOST
Papua New Guinea 843
Indonesia 709
Nigeria 530
India 454
China 309
Mexico 296
Cameroon 280
United States 239
Australia 225
Brazil 222
DR Congo 211
Philippines 184
Malaysia 133
Chad 129
Tanzania 127
Myanmar 125
Nepal 123
Russia 119
Vietnam 111
Canada 101
Peru 95
Ethiopia 92
Colombia 89
Cote d'Ivoire 88
Laos 88
Ghana 83
LEAST
Belarus 7
Bosnia and Herzegovina 7
Denmark 7
Hong Kong 7
Mauritania 7
Sri Lanka 7
Trinidad and Tobago 7
Bahrain 6
El Salvador 6
Kuwait 6
Rwanda 6
Tunisia 6
Uruguay 6
Burundi 5
Djibouti 5
Dominican Republic 5
Eswatini 5
Lesotho 5
Qatar 5
S. Korea 5
Haiti 4
Jamaica 4
New Zealand 4
Puerto Rico 4
Cuba 3
N. Korea 2
A living language is one with at least one person who speaks it as their first language.
VISUAL CAPITALIST
Source: Summer Institute of Linguistics International via Our World in Data
Includes countries and jurisdictions with populations of at least 1 million.
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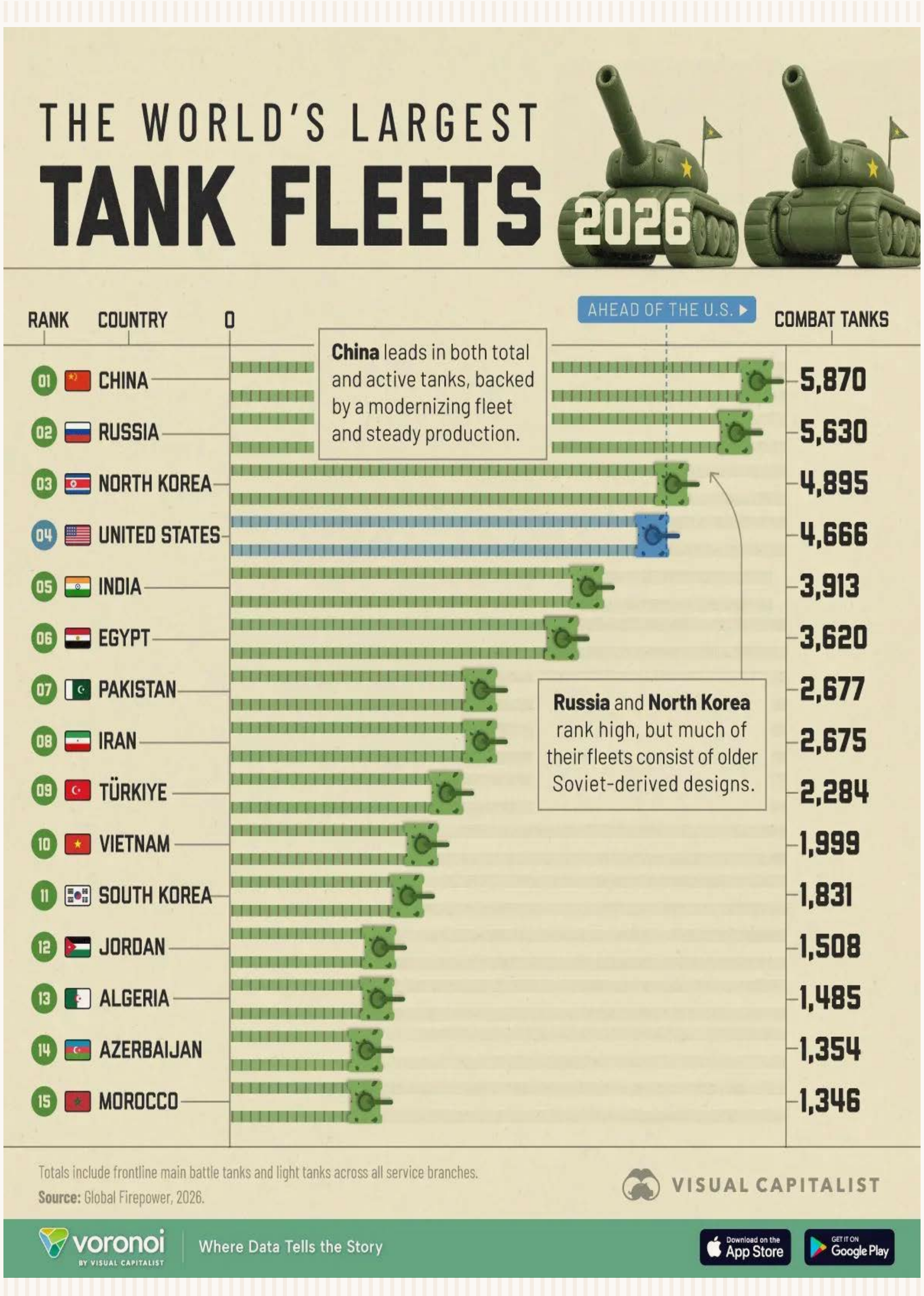

THE WORLD'S LARGEST
TANK FLEETS 2026
RANK
COUNTRY
0
AHEAD OF THE U.S.
COMBAT TANKS
China leads in both total and active tanks, backed by a modernizing fleet and steady production.
01 CHINA 5,870
02 RUSSIA 5,630
03 NORTH KOREA 4,895
04 UNITED STATES 4,666
05 INDIA 3,913
06 EGYPT 3,620
07 PAKISTAN 2,677
08 IRAN 2,675
09 TÜRKIYE 2,284
10 VIETNAM 1,999
11 SOUTH KOREA 1,831
12 JORDAN 1,508
13 ALGERIA 1,485
14 AZERBAIJAN 1,354
15 MOROCCO 1,346
Russia and North Korea rank high, but much of their fleets consist of older Soviet-derived designs.
Totals include frontline main battle tanks and light tanks across all service branches.
Source: Global Firepower, 2026.
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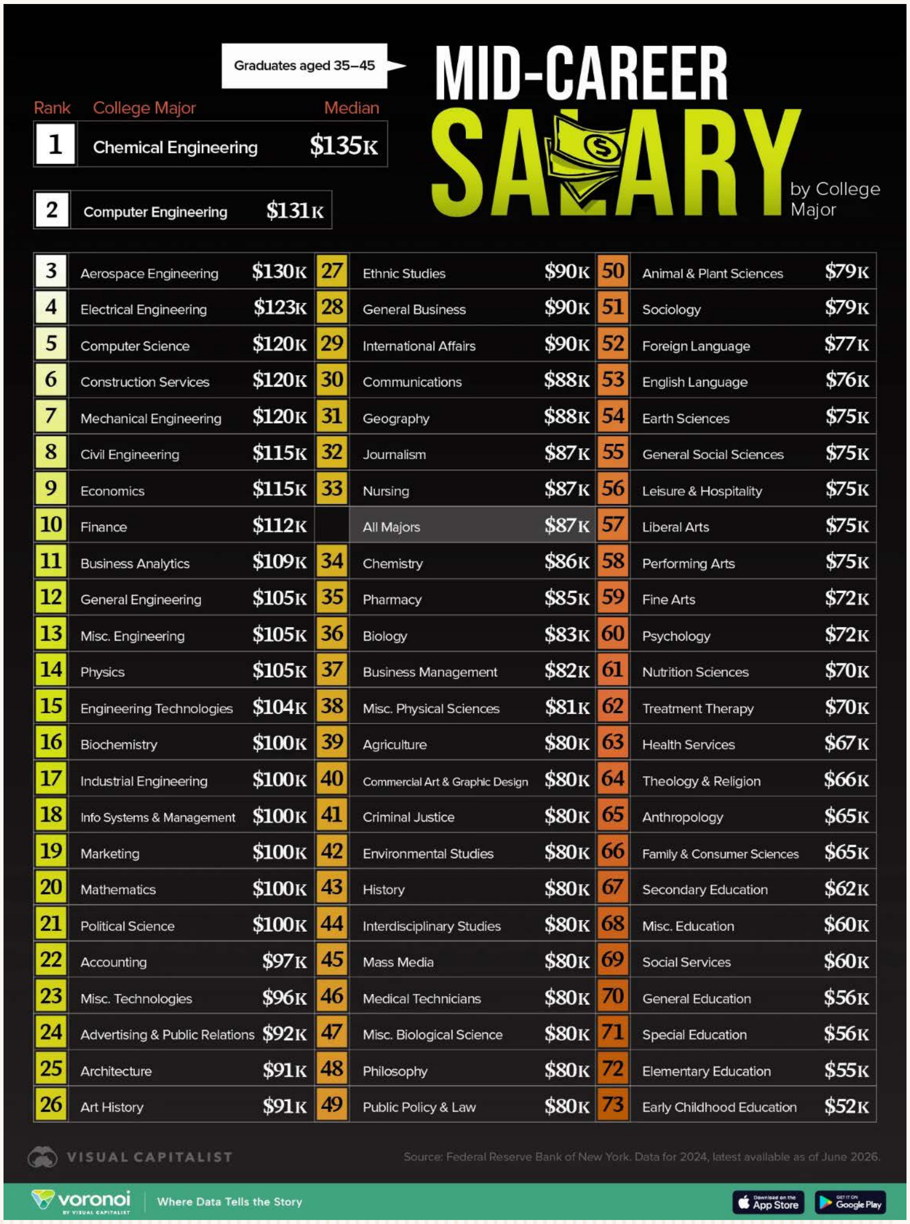

Rank	College Major	Median
1	Chemical Engineering	$135K
2	Computer Engineering	$131K

Rank	College Major	Median	Rank	College Major	Median	Rank	College Major	Median
3	Aerospace Engineering	$130K	27	Ethnic Studies	$90K	50	Animal & Plant Sciences	$79K
4	Electrical Engineering	$123K	28	General Business	$90K	51	Sociology	$79K
5	Computer Science	$120K	29	International Affairs	$90K	52	Foreign Language	$77K
6	Construction Services	$120K	30	Communications	$88K	53	English Language	$76K
7	Mechanical Engineering	$120K	31	Geography	$88K	54	Earth Sciences	$75K
8	Civil Engineering	$115K	32	Journalism	$87K	55	General Social Sciences	$75K
9	Economics	$115K	33	Nursing	$87K	56	Leisure & Hospitality	$75K
10	Finance	$112K		All Majors	$87K	57	Liberal Arts	$75K
11	Business Analytics	$109K	34	Chemistry	$86K	58	Performing Arts	$75K
12	General Engineering	$105K	35	Pharmacy	$85K	59	Fine Arts	$72K
13	Misc. Engineering	$105K	36	Biology	$83K	60	Psychology	$72K
14	Physics	$105K	37	Business Management	$82K	61	Nutrition Sciences	$70K
15	Engineering Technologies	$104K	38	Misc. Physical Sciences	$81K	62	Treatment Therapy	$70K
16	Biochemistry	$100K	39	Agriculture	$80K	63	Health Services	$67K
17	Industrial Engineering	$100K	40	Commercial Art & Graphic Design	$80K	64	Theology & Religion	$66K
18	Info Systems & Management	$100K	41	Criminal Justice	$80K	65	Anthropology	$65K
19	Marketing	$100K	42	Environmental Studies	$80K	66	Family & Consumer Sciences	$65K
20	Mathematics	$100K	43	History	$80K	67	Secondary Education	$62K
21	Political Science	$100K	44	Interdisciplinary Studies	$80K	68	Misc. Education	$60K
22	Accounting	$97K	45	Mass Media	$80K	69	Social Services	$60K
23	Misc. Technologies	$96K	46	Medical Technicians	$80K	70	General Education	$56K
24	Advertising & Public Relations	$92K	47	Misc. Biological Science	$80K	71	Special Education	$56K
25	Architecture	$91K	48	Philosophy	$80K	72	Elementary Education	$55K
26	Art History	$91K	49	Public Policy & Law	$80K	73	Early Childhood Education	$52K


More than 40% of all countries have been led by a woman
Our World in Data
% of current countries that have had a woman as chief executive since 1789. The chief executive is the head of government or the head of state, whoever has more power.
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
1789
1850
1900
1950
2025
The green line only includes countries who've had democratically-elected women leaders.
Before the mid 20th century, women only came to power via royal lineage. Since then, most have been democratically elected.
The purple line shows countries who've had any woman chief executive, regardless of how they gained office.
Data source: Varieties of Democracy Institute (V-Dem; 2026)
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Education Spending as % of GDP

Education spending varies widely across countries, reflecting differences in priorities, demographics, and fiscal capacity. Higher spending may signal stronger investment in the next generation, but ultimately, outcomes depend on efficiency, policy design, and how funds are used.

>7% | 6 - 7% | 5 - 6% | 4 - 5% | 3 - 4% | 2 - 3% | <2% | No Data

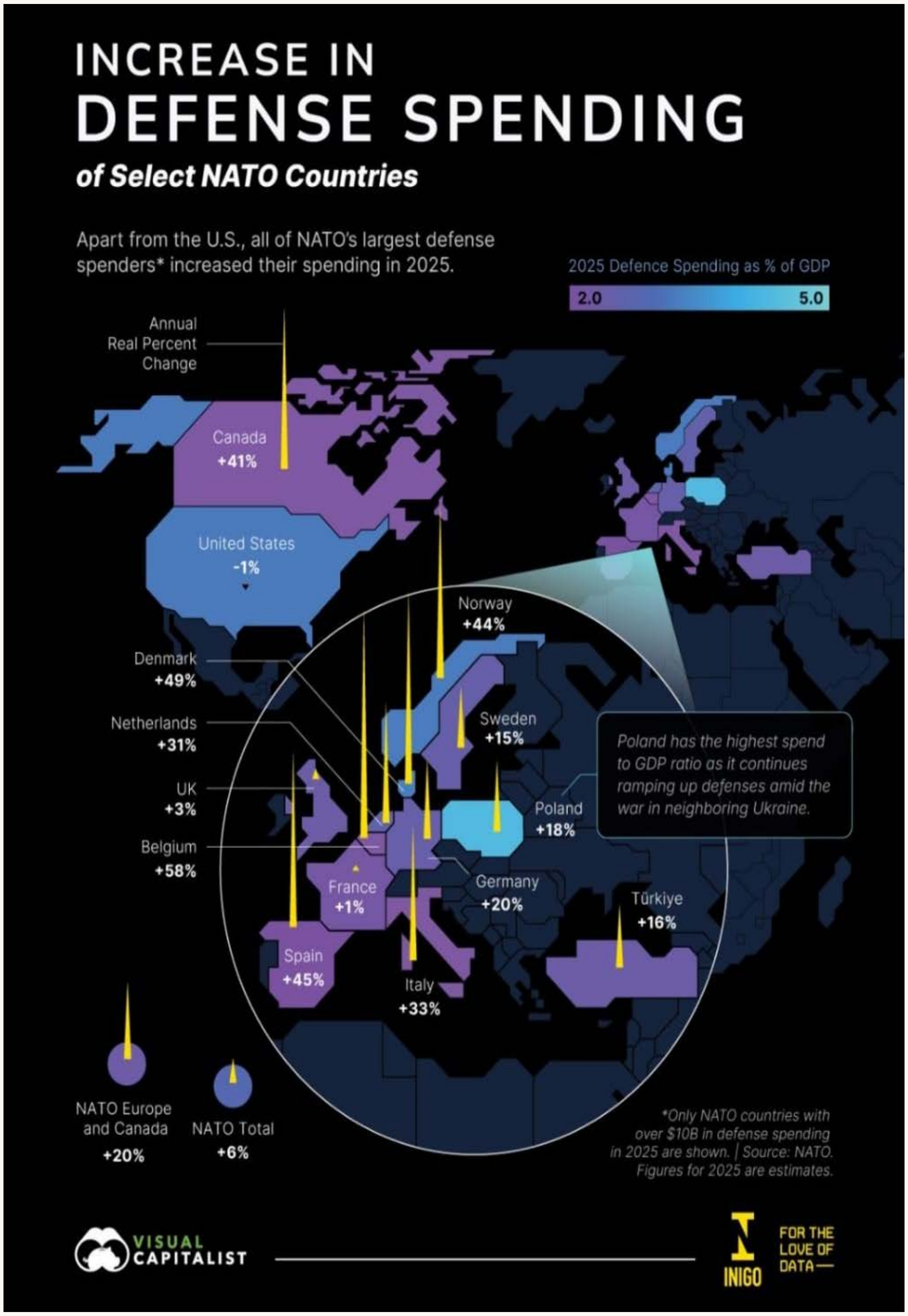
The Highest and Lowest Among Top 40 Economies

High-Income Economy | Upper-Middle | Lower-Middle

10 Highest	Spending as % of GDP	% population aged 24 and below
Sweden	7.3%	28.4%
Denmark	6.4%	27.6%
Belgium	6.3%	27.4%
S. Africa	6.0%	42.1%
Israel	5.9%	42.8%
U.K.	5.9%	28.8%
Brazil	5.6%	33.6%
Norway	5.4%	28.2%
U.S.	5.4%	30.3%
S. Korea	5.4%	19.9%

10 Lowest	Spending as % of GDP	% population aged 24 and below
Indonesia	1.3%	40.2%
Pakistan	2.0%	56.2%
Bangladesh	2.0%	46.6%
Singapore	2.2%	25.6%
Thailand	2.5%	26.9%
Vietnam	2.9%	36.6%
Ireland	2.9%	31.6%
Turkiye	3.1%	35.4%
Romania	3.3%	26.7%
Japan	3.3%	20.8%

Source: **Education Spending:** *UNESCO via OurWorldInData. Figures reflect most recent data available, last updated in 2025. Figures rounded to nearest 0.1%*
Population Aged 24 and below: *UN Population Division, 2025.*


INCREASE IN
DEFENSE SPENDING
of Select NATO Countries
Apart from the U.S., all of NATO's largest defense spenders* increased their spending in 2025.
2025 Defence Spending as % of GDP
2.0
5.0
Annual Real Percent Change
Canada +41%
United States -1%
Norway +44%
Denmark +49%
Netherlands +31%
Sweden +15%
UK +3%
Poland +18%
Belgium +58%
Germany +20%
France +1%
Türkiye +16%
Spain +45%
Italy +33%
Poland has the highest spend to GDP ratio as it continues ramping up defenses amid the war in neighboring Ukraine.
NATO Europe and Canada +20%
NATO Total +6%
*Only NATO countries with over $10B in defense spending in 2025 are shown. | Source: NATO. Figures for 2025 are estimates.
VISUAL CAPITALIST
INIGO
FOR THE LOVE OF DATA


RELATIVE POWER SCORE 2026
U.S. 100
China 93.6
Russia 91.4
UK 84.3
Germany 74.1
South Korea 62.7
Saudi Arabia 61.0
France 59.5
Japan 59.0
UAE 58.6
Israel 56.4
India 45.0
Canada 42.1
Türkiye 32.7
Italy 31.6
Iran 28.4
Switzerland 27.6
Ukraine 27.6
Australia 26.1
Spain 25.2
Brazil 21.7
Singapore 20.4
Sweden 19.5
Netherlands 18.6
Belgium 17.6
Kuwait 17.6
Denmark 16.9
Mexico 15.4
Egypt 14.3
Vietnam 14.2
South Africa 13.7
Norway 12.9
Indonesia 12.1
Poland 10.8
Portugal 10.7
Belarus 10.2
Austria 10.1
Argentina 9.7
Finland 9.4
Bangladesh 8.9
most powerful
COUNTRIES
in 2026
Based on a survey of 15,131 adults in 33 countries.
Source: 2026 Best Countries Index, The Wharton School.
Survey conducted between Dec 2025 and Feb 2026.
Analysis covers 85 countries. Top-ranked country is indexed to 100.
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